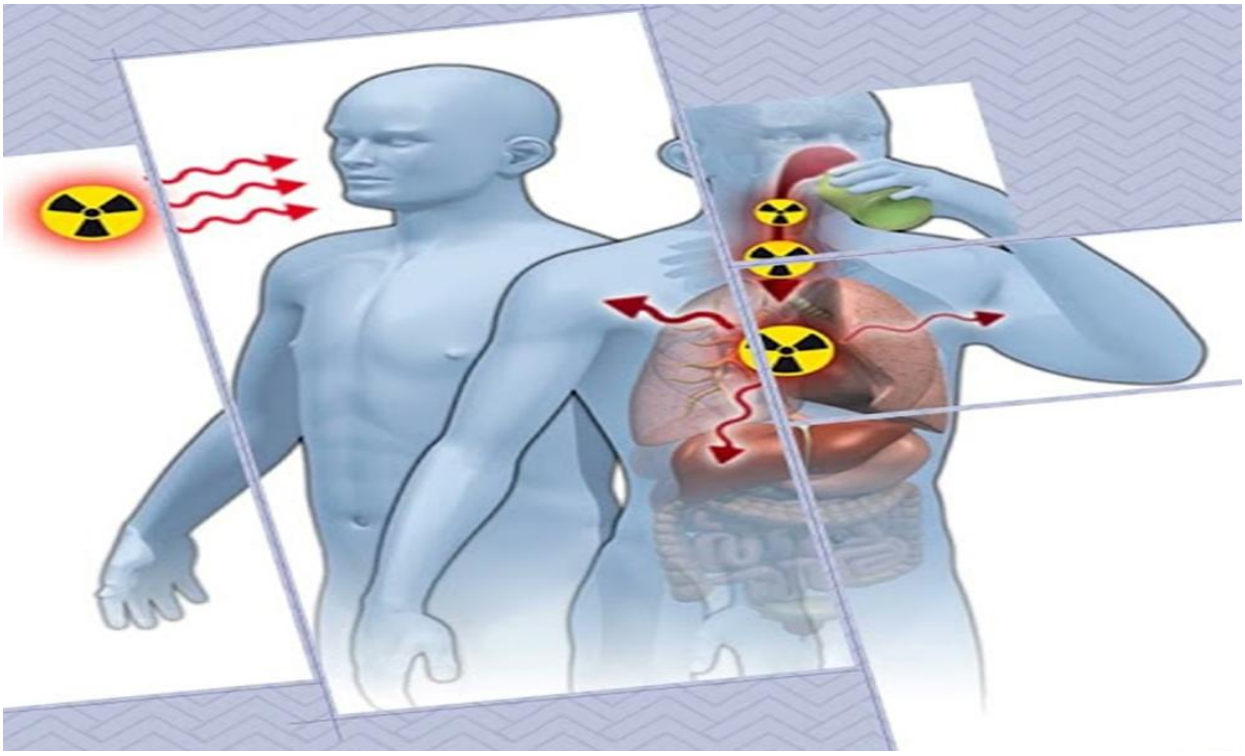
Local Tissue Effects on Gonads
8th Lecture



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Teaching of Biological Radiation hazards

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1. Local Tissue Effects on Gonads

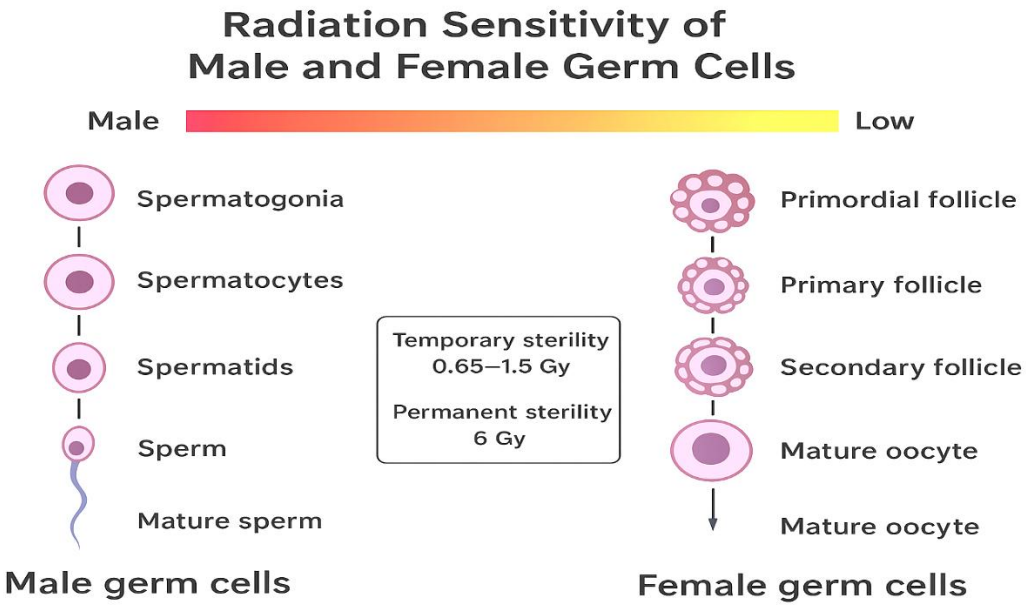
These are deterministic effects (they have a threshold dose).

Cells that divide rapidly—such as intestinal, bone marrow, and reproductive cells—are highly radiosensitive, making the male and female reproductive systems particularly vulnerable to ionizing radiation.

Male spermatogonia are the most sensitive germ cells; high-dose exposure can lead to reduced sperm counts, azoospermia, temporary sterility, or permanent sterility at doses around 6 Gy.

In females, mature oocytes are the most radiosensitive reproductive cells, with temporary sterility reported at 0.65–1.5 Gy, though fractionated higher doses can be tolerated. Human studies, including evaluations of Chernobyl accident victims, show decreased libido, hormonal disturbances, and sperm anomalies after exposures of 1–5.5 Gy.

Animal studies support these findings, demonstrating decreased fertility, testicular atrophy, sperm abnormalities, dominant lethal mutations, and embryo loss at doses between 1–11 Gy. Overall, high radiation doses impair reproductive function across species due to damage to rapidly dividing germ cells.



In Males (Testes):

- 0.1 – 0.2 Gy: Temporary reduction in sperm count.
- 0.65 – 1.5 Gy: Temporary sterility (several months).
- > 3.5 – 6 Gy: Permanent sterility.

In Females (Ovaries):

- 0.5–2 Gy: Reduction in ovarian follicles.
- > 2–3 Gy: Permanent infertility possible.
- Females are more radiosensitive because they are born with a fixed number of oocytes.

2. Life Span Shortening

- A stochastic effect, meaning no threshold.
- Radiation increases the probability of cancer and other late effects → can reduce life expectancy.
- It doesn't shorten life directly; it increases long-term disease risk.

3. Effect on Fertility

Depends on:

- Dose
- Type of germ cells
- Age

In Males:

- Lower doses → temporary infertility.
- Higher doses → permanent infertility.
- Mature sperm cells are less sensitive than spermatogonia.

In Females:

- Ovaries are highly sensitive.
- Increasing age = increasing sensitivity.
- Doses above ~2–3 Gy can cause permanent sterility.

4. In Utero Effects (Effects on the Embryo/Fetus)

Strongly dose- and age-dependent.

0–2 weeks (Pre-implantation):

- All-or-none effect: death or no effect.
- Malformations rarely occur in this stage.

2–8 weeks (Organogenesis):

- Highest risk of structural congenital malformations (heart, limbs, CNS).

8–15 weeks:

- Highest risk of severe mental retardation and brain growth problems.

15–25 weeks:

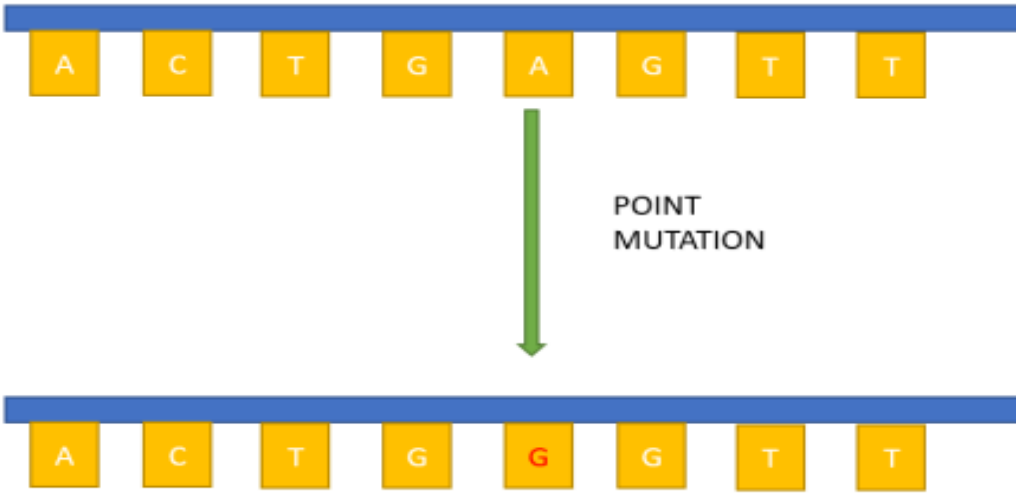
- Lower but still present risk of mental retardation.
- Increased risk of childhood cancers.

> 25 weeks:

- Malformation risk is low.
- Cancer risk remains.

5. Genetic Effects (Hereditary Effects)

- Result from DNA damage in germ cells.
- Effects appear in future generations, not the exposed individual.
- Include:
    - Genetic mutations



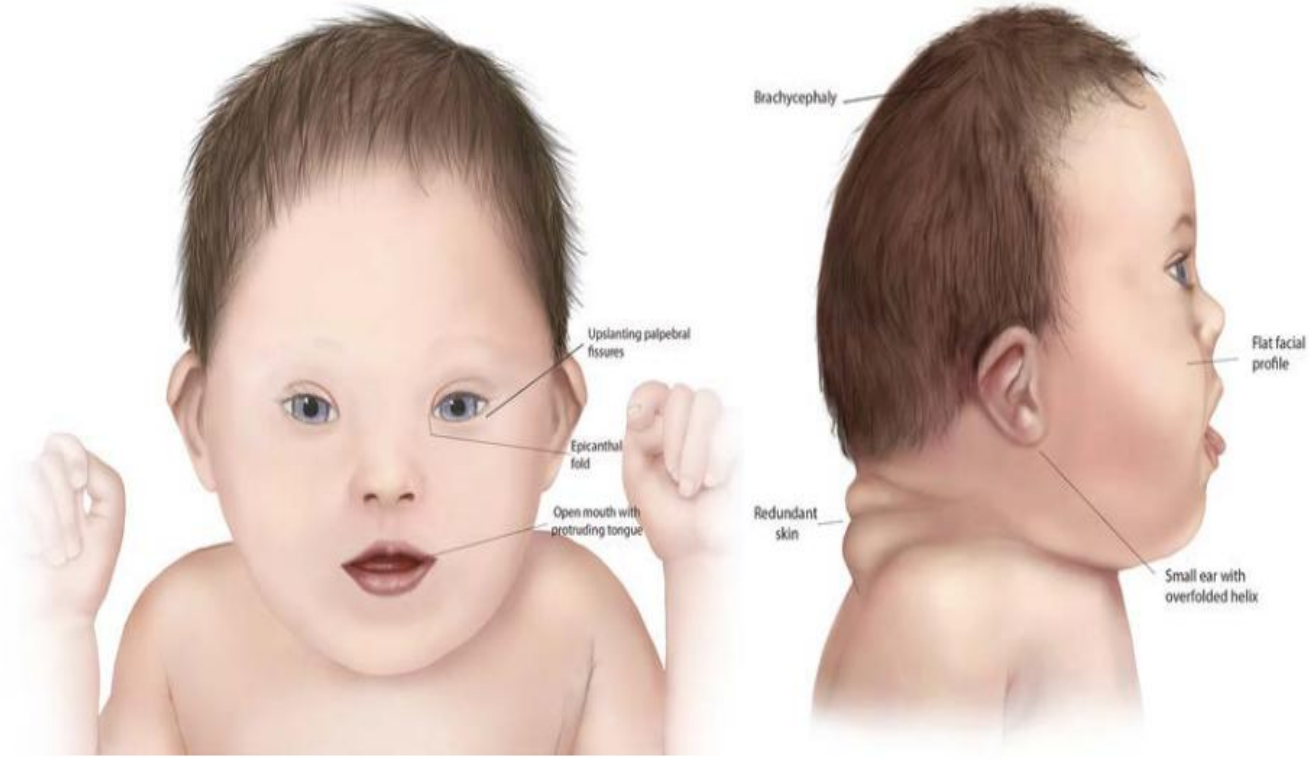
    - Heritable diseases

Front View (Left Image):

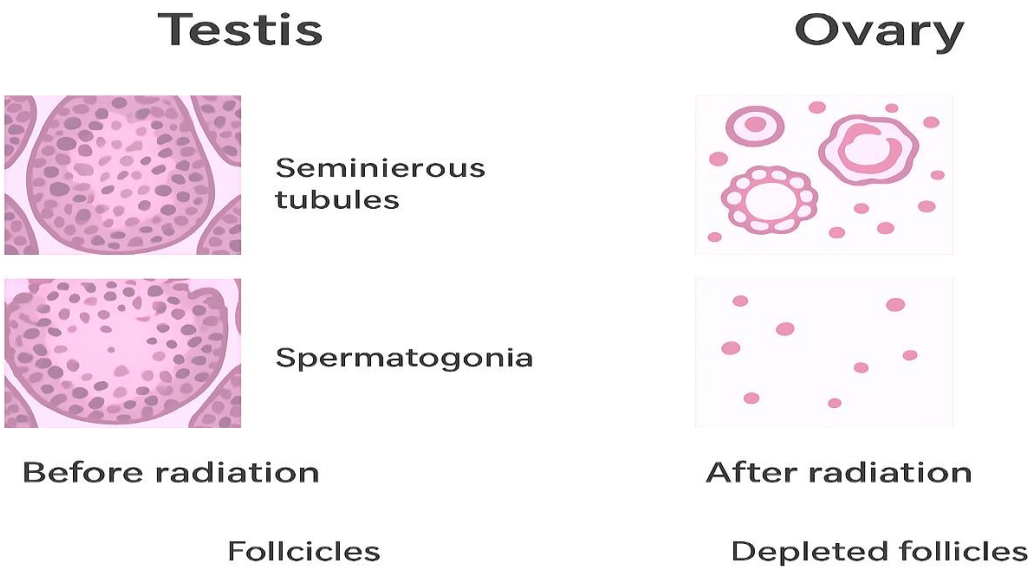
- Upslanting palpebral fissures
- Epicanthal fold
- Open mouth with protruding tongue

Side View (Right Image):

- Brachycephaly
- Flat facial profile
- Small ear with overfolded helix
- Redundant skin



Proven in animals, but no confirmed hereditary radiation effects in humans so far.



Gonadal Tissue Response to Radiation: Normal vs. Post-Exposure Histology